

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : **CASIO COMPUT CO LTD**

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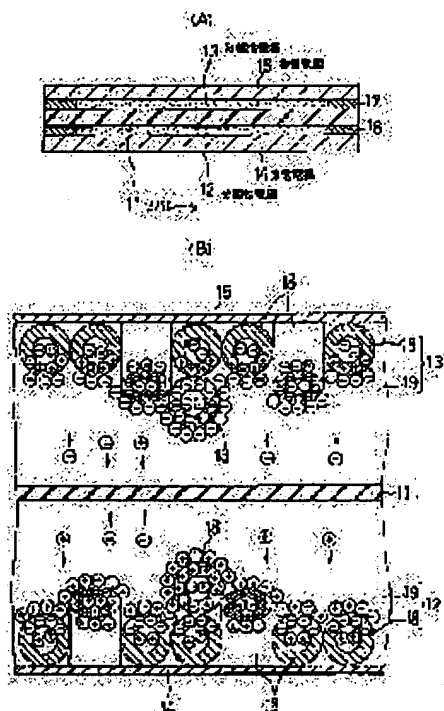
(72)Inventor : **IKEDA NAOTO**

(54) ELECTRICAL DOUBLE LAYER CAPACITOR

(57)Abstract:

PROBLEM TO BE SOLVED: To further increase the energy density of an electrical double layer capacitor.

SOLUTION: Tubular carbon fibers 18 called carbon nano-tubes are used for polarizable electrodes 12 and 13. Since the tubular carbon fibers 18 have outside diameters of 1-500 nm, the surface area per unit volume of tubular carbon fiber groups can be increased further as compared with the case where activated carbon particles are used for the polarizable electrodes and, in its turn, the energy density of an electrical double layer electrode can be increased further.



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CLAIMS

[Claim(s)]

[Claim 1] The electric double layer capacitor characterized by consisting of at least one electric double layer capacitor unit which comes to arrange the polarizable electrode equipped with the electrode arranged so that it may consist of many minute conductive tubes and each opposed face side of the current collection electrode of the pair by which opposite arrangement was carried out may not be contacted mutually, respectively.

[Claim 2] The electric double layer capacitor according to claim 1 which carries out the laminating of said two or more electric double layer capacitor units so that current collection electrodes may contact, and is characterized by coming to connect said two or more electric double layer capacitor units with a serial.

[Claim 3] The electric double layer capacitor according to claim 1 which carries out the laminating of said two or more electric double layer capacitor units through an insulating spacer, and is characterized by coming to connect said two or more electric double layer capacitor units with juxtaposition.

[Claim 4] Said conductive tube is an electric double layer capacitor according to claim 1 to 3 characterized by consisting of a tube-like carbon fiber with an outer diameter of about 1-500nm.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to an electric double layer capacitor.

[0002]

[Description of the Prior Art] Drawing 4 shows the sectional view of an example of the conventional electric double layer capacitor. In this electric double layer capacitor, it has the structure where the polarizable electrodes 2 and 3 which become the both sides of the porous separator 1 which have ionic permeability and non-electronic conduction nature from many activated carbon particles (electrode) and electrolytic solutions were formed, the current collection electrodes 4 and 5 which have non-ionic permeability and electronic conduction nature on those both sides were formed, and the gaskets 6 and 7 of the shape of a frame which consists of insulating rubber etc. were formed between the each perimeter of both sides of a separator 1, and the current collection electrodes 4 and 5. In this case, it is because it can enlarge surface area per unit volume of an activated carbon particle group with about 10-50 micrometers since particle diameter is quite small, as a result using the activated carbon particle as an electrode of polarizable electrodes 2 and 3 can enlarge energy density.

[0003]

[Problem(s) to be Solved by the Invention] However, in such a conventional electric double layer capacitor, although it was small, since it became, and the limitation was shown in the surface area per unit volume of an activated carbon particle group, about 10-50 micrometers and the problem that there was a limitation also in energy density had activated carbon particle diameter. The technical problem of this invention is enlarging further surface area per unit volume of the electrode of a polarizable electrode.

[0004]

[Means for Solving the Problem] This invention uses many minute conductive tubes as an electrode of a polarizable electrode. Invention according to claim 4 uses a tube-like carbon fiber with an outer diameter of about 1-500nm as a conductive tube.

[0005] According to this invention, since the conductive tube minute as an electrode of a polarizable electrode is used, surface area per unit volume of a conductive tube group can be made larger [one layer of nearby] than the case where an activated carbon particle is used as an electrode of a polarizable electrode.

[0006]

[Embodiment of the Invention] Drawing 1 (A) shows the sectional view of the electric double layer capacitor in the 1st operation gestalt of this invention, and drawing 1 R> 1 (B) shows that typical expanded sectional view. In this electric double layer capacitor, it has the structure where polarizable electrodes 12 and 13 were formed in the both sides of a separator 11, the current collection electrodes 14 and 15 were formed in those both sides, and the frame-like gaskets 16 and 17 were formed between the each perimeter of both sides of a separator 11, and the current collection electrodes 14 and 15. Among these, polarizable electrodes 12 and 13 consist of many minute tube-like carbon fibers (conductive tube)

18 and electrolytic solutions 19. In this case, the tube-like carbon fiber 18 is being called the carbon nanotube. In addition, a separator 11 can be omitted when there is no possibility that tube-like carbon fiber 18 comrades in the polarizable electrodes 12 and 13 of both sides may contact directly.

[0007] Here, the formation approach of the tube-like carbon fiber 18 called a carbon nanotube is explained. For example, if a carbon deposit is grown up into the front face of the carbon rod electrode of a negative electrode and this grown-up carbon deposit is gathered up by making two carbon rod inter-electrode arranged in glassware in the glassware which enclosed inert gas, such as helium of 100 - 500Torr extent, and Ar, produce DC arc discharge, the tube-like carbon fiber 18 will be obtained. Thus, the outer diameter of the obtained tube-like carbon fiber 18 is about 1-500nm, and die length is about 0.05-500 micrometers. There is the approach of applying to a separator 11 or the current collection electrodes 14 and 15 the paste which comes to mix the tube-like carbon fiber 18 and an electrolytic solution 19 as an approach incorporating this tube-like carbon fiber 18.

[0008] Thus, since the outer diameter of the tube-like carbon fiber 18 used as an electrode of polarizable electrodes 12 and 13 is about 1-500nm and die length is about 0.05-500 micrometers, surface area per unit volume of tube-like carbon fiber 18 group can be made larger [one layer of nearby] than the case where an activated carbon particle is used as an electrode of a polarizable electrode, as a result energy density can be enlarged further. In this case, in order to enlarge more surface area per unit volume of tube-like carbon fiber 18 group, as small the one of the outer diameter of the tube-like carbon fiber 18 as possible is desirable, for example, its about 1-100nm is desirable. By the way, since the tube-like carbon fiber 18 is a tube-like literally, a function is possible not only for the peripheral face but its inner skin as an electrode surface. On the other hand, if it takes into consideration that the tube-like carbon fiber 18 is crushed, it is not so desirable that the tube-like carbon fiber 18 is too long. For this reason, the die length of the tube-like carbon fiber 18 has desirable about 0.05-10 micrometers.

[0009] Here, the case of the charge condition of this electric double layer capacitor is briefly explained with reference to drawing 1 (B). When the current collection electrode 14 is used as a negative electrode and it charges by using the current collection electrode 15 as a positive electrode, the front face of the tube-like carbon fiber 18 of the polarizable electrode 12 by the side of a negative electrode will be adsorbed in both the electrolytic solutions 19 and the plus ion in 22, and the front face of the tube-like carbon fiber 18 of the polarizable electrode 13 by the side of a positive electrode will be adsorbed in the anion in both the electrolytic solutions 19 and 22.

[0010] Next, drawing 2 shows the sectional view of the electric double layer capacitor in the 2nd operation gestalt of this invention. The 1st current collection electrode 14 with which, as for this electric double layer capacitor, the 1st polarizable electrode 12 which consists of many minute conductive tubes and electrolytic solutions was formed in the top face, In this order, make gaskets 16 and 17 placed between each of those **, and the laminating of a separator 11 and the 2nd current collection electrode 15 with which the 2nd polarizable electrode 14 which consists of many minute conductive tubes and electrolytic solutions was formed in the inferior surface of tongue is carried out to them. Constitute one electric double layer capacitor unit 21, and the laminating of two or more (drawing 2 four pieces) these electric double layer capacitor units 21 is carried out. While containing this thing that carried out the laminating in the insulating barrel 22 which consists of insulating resin of the shape of the shape of an rectangular pipe, and a cylinder and covering the insulating barrel 22 in the positive-electrode case 23 and the negative-electrode case 24 which consist of aluminum, stainless steel, etc. It has structure which formed the spacer 25 which consists of insulating resin between the side attachment wall of the positive-electrode case 23 where it is located inside, and the side attachment wall of the negative-electrode case 24 where it is located outside. In this case, the inferior surface of tongue of the 1st current collection electrode 14 of the electric double layer capacitor unit 21 of the lowest layer is close to the lower inside of the negative-electrode case 24, and the top face of the 2nd current collection electrode 15 of the electric double layer capacitor unit 21 of the maximum upper layer is close to the up inside of the positive-electrode case 23. Therefore, in this electric double layer capacitor, it has structure which connected two or more electric double layer capacitor units 21 to the serial.

[0011] By the way, when the current collection electrodes 14 and 15 are formed with aluminum foil with

a thickness of about 30 micrometers, a separator 11 is formed with a resin film with a thickness of about 30 micrometers and thickness of a polarizable electrode 12 is set to about 5 micrometers, thickness of one electric double layer capacitor unit 21 can be set to about 100 micrometers. And even if it constitutes an electric double layer capacitor as carried out the ten-piece laminating of such an electric double layer capacitor unit 21, for example and shown in drawing 2, the thickness (except for the thickness of both the cases 22 and 23) can be made quite thin with about 1mm.

[0012] In addition, although drawing 2 explained the case where two or more electric double layer capacitor units 21 were connected to a serial, it is also connectable with juxtaposition like the 3rd operation gestalt of this invention shown, for example in drawing 3. In this case, the electric double layer capacitor unit 21 is a flat-surface rectangle-like, and has structure which the left end section of the 1st current collection electrode 14 was bent, the left end side of a separator 11 and gaskets 16 and 17 ****(ed), and the right end section of the 2nd current collection electrode 15 was bent, and was ****(ed) by the right end side of a separator 11 and gaskets 16 and 17. It is placed between each ** of four electric double layer capacitor units 21 by the spacer 31 which consists of an insulating resin sheet. The about L character-like negative-electrode plate 32 is close to the inferior surface of tongue of the 1st current collection electrode 14 of the electric double layer capacitor unit 21 of the left end bending section of the 1st four current collection electrodes 14 of the electric double layer capacitor unit 21, and the lowest layer. The positive-electrode plate 33 made into the shape of about L characters in the part is close to the top face of the 12th current collection electrode 15 of the electric double layer capacitor unit 21 of the right end bending section of the 2nd four current collection electrodes 15 of the electric double layer capacitor unit 21, and the maximum upper layer. The insulating member 34 which consists of mold resin is formed in the perimeter of the part except each point of the negative-electrode plate 32 and the positive-electrode plate 33, and four electric double layer capacitor units 21, and the sheathing case 35 which consists of aluminum, stainless steel, etc. is formed in the perimeter. Thus, in this electric double layer capacitor, it has structure which connected four electric double layer capacitor units 21 to juxtaposition.

[0013] In addition, although drawing 2 and drawing 3 explained the case where the laminating of two or more electric double layer capacitor units 21 was carried out, it is not limited to this. For example, the 1st long picture current collection electrode with which the 1st polarizable electrode which consists of many minute conductive tubes and electrolytic solutions was prepared in the field of 1 although not illustrated, While carrying out the laminating of the 2nd long picture current collection electrode with which the 2nd polarizable electrode which consists of many minute conductive tubes and electrolytic solutions was prepared in a long picture separator and other fields, and the long picture spacer which consists of an insulating resin sheet in this order It is good also as structure of coming to wind this thing that carried out the laminating in the shape of a roll. In addition, after an electrolytic solution's rolling the 1st and 2nd current collection electrodes which adhered to the conductive tube, a separator, and a spacer in the shape of a roll and containing this rolled thing in an insulating case in this case, a conductive tube is infiltrated, it makes in it and you may make it include in it.

[0014] Moreover, although the above-mentioned explanation explained the case where the paste which comes to mix a tube-like carbon fiber and an electrolytic solution was applied to about 5 micrometers in thickness as an example at the 1st and the 2nd current collection electrode 14, and 15 grades, it is not limited to this. For example, it is one layer, respectively, is mutually close to each opposed face of the current collection electrodes 14 and 15, and you may make it arrange many tube-like carbon fibers. Moreover, it is one layer, respectively and you may make it arrange many tube-like carbon fibers every other sparsely to each opposed face of the current collection electrodes 14 and 15.

[0015]

[Effect of the Invention] Since the conductive tube minute as an electrode of a polarizable electrode is used according to this invention as explained above, surface area per unit volume of a conductive tube group can be made larger [one layer of nearby] than the case where an activated carbon particle is used as an electrode of a polarizable electrode, as a result energy density can be enlarged further.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] For (A), the sectional view of the electric double layer capacitor in the 1st operation gestalt of this invention and (B) are that typical expanded sectional view.

[Drawing 2] The sectional view of the electric double layer capacitor in the 2nd operation gestalt of this invention.

[Drawing 3] The sectional view of the electric double layer capacitor in the 3rd operation gestalt of this invention.

[Drawing 4] The sectional view of the conventional electric double layer capacitor.

[Description of Notations]

11 Separator

12 13 Polarizable electrode

14 15 Current collection electrode

18 Tube-like Carbon Fiber

19 Electrolytic Solution

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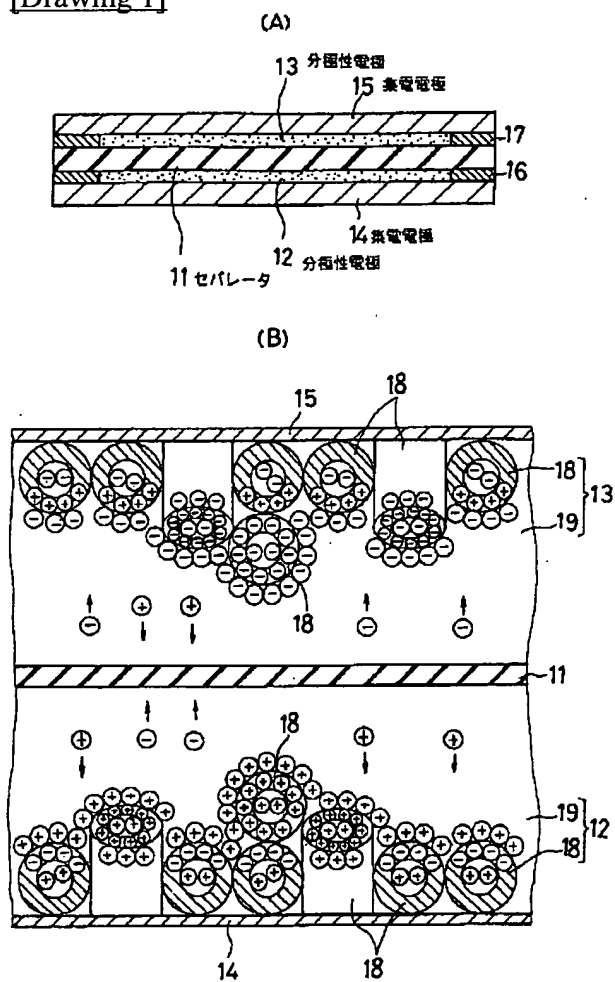
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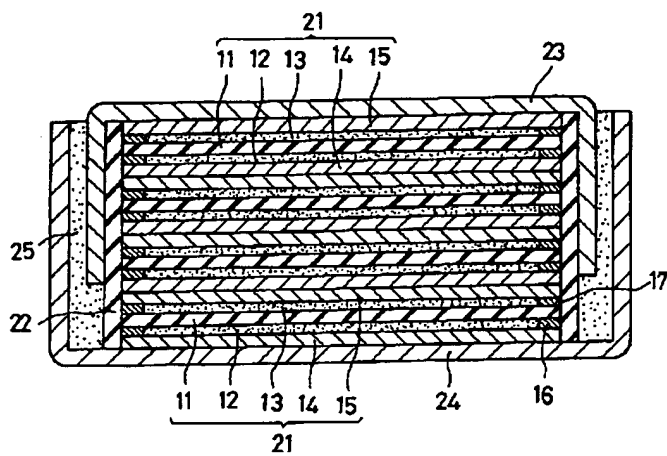
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DRAWINGS

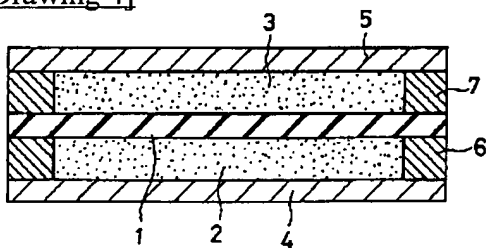
[Drawing 1]



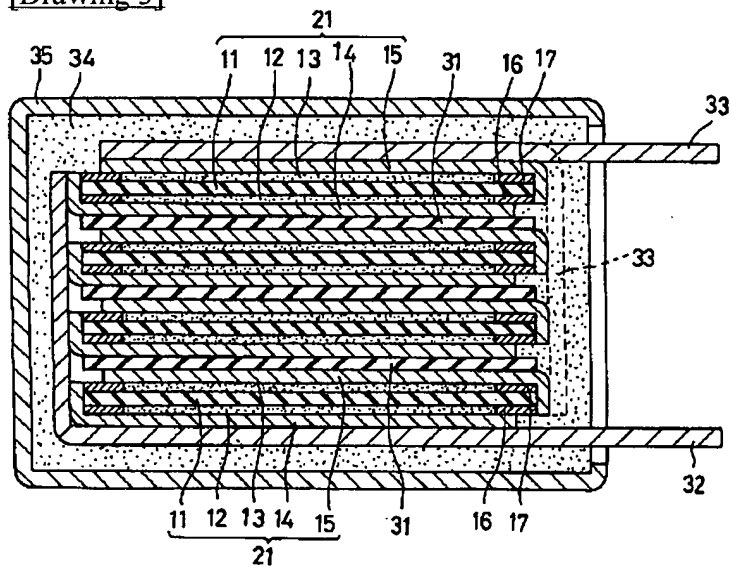
[Drawing 2]



[Drawing 4]



[Drawing 3]



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